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the molecule. As there is no good reason for supposing the motions of these parts or atoms to be rather in one plane than another, we must admit the possibility of motion in all planes. The vibrations would, however, probably be in three planes at right angles to one another in all molecules of more than three atoms; and would, consequently, have six points of maximum displacement and minimum density of the surrounding ether. Molecules of two and three atoms might possibly vibrate in two or only one plane. As molecules are not vortex-rings, though possibly groups of vortex-rings, the analogy to a vibrating tuning fork becomes much closer than in the case of a vibrating vortex-ring, and we are much more justified in trying to make application of the hypothesis. Prof. Dolbear's analogy thus modified can, I think, be made a very fair working hypothesis to explain adhesion, cohesion and even crystallization. The phenomena of surface tension of liquids and capillary action find a reasonably fair explanation upon this hypothesis, and possibly also those of osmosis, dialysis and occlusion. But even here such an hypothesis meets with many difficulties and we must exercise extreme caution, and must gather further experimental evidence before committing ourselves to its acceptance.

In his second paper the Professor tells us that the vortex-ring theory assumes that matter is a *form of energy*, etc. Never having been so fortunate as to have had access to Sir William Thomson's original memoir, I know his celebrated hypothesis only through interpretations of others. From these interpretations I have always supposed that this hypothesis assumes that all matter is essentially one; and that the elements, as we know them, are portions of this common matter imbued with vortex-motion, thus forming vortex-rings variously knotted, whose energy is non-interchangeable with other forms of energy provided the vortex-rings are formed and exist in a perfect or frictionless fluid. If the fluid is not quite perfect, not quite frictionless, the vortex-rings must gradually be destroyed and their energy must be transformed. The uniform material substratum, if I understand the hypothesis correctly, consists of smaller and simpler vortex-rings which are also the particles or atoms of the ether. If, then, I comprehend the positions, the non-transformability of the energy of the vortex atoms and also their permanence, *i. e.* the persistence of our elements depend upon the perfect fluidity of the ether. Whether the ether is perfectly frictionless or not science is, I think, hardly ready to answer. To call "*matter a form of energy not interchangeable with other variable forms*" is, under the circumstances and from the meaning of the terms employed, to take extraordinary liberties with language. Physically regarded, energy is, to strip the term of all technicalities, matter in motion. Then Professor Dolbear's statement becomes matter, is a form of matter in motion, which is hardly intelligible. Again we are told "The energy of a mass of matter varies as the square of the velocities, but the *properties* of the mass vary with the form of the energy, that is to say the physical properties of a heated body are not identical with those of the same body when it is cool, but possesses the same amount of energy in free path motion." Exactly what this sentence means is, I must confess, beyond my comprehension. One thing, however, seems certain, that it expresses an idea directly opposed to the "Mechanical Theory of Heat" and the "Kinetic Theory of Gases" in the statement that a cool body "possesses the same amount of energy in free path motion" as the same body when heated. If this be so, what becomes of $\frac{v \dot{p}}{\tau} = \frac{v' \dot{p}'}{\tau'}$ for gases, and what of the "Thermo-dynamic Scale of Temperature."

In regard to the assumption $\frac{mv^2}{2}$ = atomic weight and the calculations based thereon, I will merely remark that if

the groups having the same *m* or those having the same *v* showed any family likeness or any gradual variation of properties as do Mendelejeff's periods and groups, then they would be worthy of consideration. As it is, however, they seem mere jugglery with figures. That the atoms of the elements have a "common form differing arithmetically from each other in size and velocity" is utterly inconsistent with the well-known facts and phenomena of quantivalence or valency of atoms. There would have to be two forms at least one for artiad, and one for perissad atoms. I think for the present, at least, we must reject this idea of simplicity and still follow Sir William Thomson.

In the third paper we read, "There is now sufficient evidence for the belief that the Kinetic energy of atoms and molecules consists of two parts, one of which is the energy of translation or free path, the other of a change of form due to vibrations of the parts of the atom or molecule toward or away from its centre of mass. The pressure of a gas is immediately due to the former while the temperature depends solely upon the latter." To the first sentence of this quotation I object, because atoms and molecules are treated as if similar, for which assumption we have no evidence. The second sentence contains the very strange idea that the temperature of a gas is due only to the internal energy of the molecule. Maxwell in his "Theory of Heat" Chap. XXII, under "Specific Heat at Constant Volume" says: "Since the product *p**v* is proportional to the absolute temperature, the energy is proportional to the temperature." By energy Maxwell here means, as appears from the context, what Prof. Dolbear would call total energy. From this it appears that Prof. Dolbear's statement can hardly be correct. If we remember that Maxwell speaks of molecules and Prof. Dolbear of atoms the latter's statement becomes still more doubtful. The assumption that "these two forms of energy must indeed be equal to each other in a gas under uniform conditions," upon which all the Professor's calculations in his third paper are based, can easily be disproved. The Kinetic energy of agitation of a molecule is $\frac{1}{2} mv^2$ and the (total) energy is " $\frac{1}{2} \beta mv^2$ " where β is a factor always greater than unity and probably equal to 1.634 for air and several of the more perfect gases." Hence the internal energy is $\frac{1}{2} (.634 mv^2)$. This, of course, invalidates all the Professor's calculations.

Having extended my remarks far beyond what I originally intended, I shall touch upon only one more point, though I find various other difficulties in the Professor's speculations. The last paragraph of the third paper begins: "As at absolute zero each atom is quite independent of every other atom, that is, matter has not a molecular structure, etc." Now, I would like to ask the Professor how he knows this. Such a state of affairs would indeed make the absolute zero a more than singular point in the curve of the properties of matter.

BUFFALO, N. Y., April 20, 1881.

WM. H. DOPP.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.]

INTRA-MERCURIAL PLANETS.

To the Editor of "SCIENCE:."

I wish to say that in the sketch given to "SCIENCE," No. 35; p. 95, the position of Professor Swift's Vulcans is very nearly as they were put down by Professor Swift himself on a map that now hangs in my room at the Naval Observatory.

As to negative evidence there is something to be said on both sides of the question. When extraordinary discoveries are reported they are to be severely examined and carefully criticised. If the observations on which

the discoveries rest are conflicting among themselves, and if the probability of such discoveries is rendered small by long and careful series of independent observations, we are justified in waiting for further evidence before we accept the alleged discoveries as true. The ways in which an observer may be deceived are numerous. In 1878 an astronomer wrote me that he had discovered a satellite of Venus that revolved around the planet in thirty seconds. I expressed some doubt and advised him to examine his telescope and the eye pieces. He did so and was candid enough to inform me that the satellite he had discovered was nothing but a "ghost."

If any astronomer who is familiar with astronomical observations and their discussion, will examine the reports on the Vulcans supposed to have been discovered during the eclipse of 1878, and will notice how the reports were changed from time to time, he will find good reasons for doubt. Certainly this matter is not to be settled by assertion. If there are Vulcans of the fourth and fifth magnitudes which attain an angular distance of from three to seven degrees from the sun, they ought to be found easily.

A. HALL.

Washington, April 25, 1881.

THE SOLAR PARALLAX.

To the Editor of "SCIENCE":

From the American photographs of the Transit of Venus, as presented in part the first of "Observations of the Transit of Venus, December 8, 9, 1874, Made and Reduced Under the Direction of the Commission Created by Congress," I have obtained, for the value of the solar parallax, $8.883'' \pm 0.034''$ corresponding to a distance between the centres of the sun and the earth equal to 92,028,000 miles.

D. P. TODD.

WASHINGTON, April 26, 1881.

ASTRONOMY.

MOUNT ETNA OBSERVATORY.—The *Memoirs* of the Italian Spectroscope Society contains an illustration of the Observatory of Mount Etna, showing that work upon the building has progressed as rapidly as could have been expected, when we consider the difficulties to be overcome in the transportation of materials, etc. Every effort is being made to finish the Observatory by 1882, and provide it with a director and staff both of astronomers and meteorologists.

W. C. W.

Messrs. Houzeau and Lancaster, the Director and Librarian of the Bruxelles Observatory, are performing an extremely valuable service to astronomers by the preparation of a general bibliography of Astronomy. Two volumes have thus far appeared, the second of which is just published, and is devoted to memoirs which have appeared in scientific periodicals, and in the publications of the various academies. Four topics are included in this volume, Spherical Astronomy, Theoretical Astronomy, Celestial Mechanics, and Physical Astronomy. The only thing which even approximates the completeness of the present work, is the catalogue of the library of the Poulkova Observatory, a new edition of which has been in course of preparation for several years past. The Bruxelles work, however, has the advantage of being a general bibliography, and not limited to the contents of any one library, however extensive.

O. S.

MICROSCOPICAL NOTES.

At our suggestion, Mr. Lockwood, of New York City, who has already devoted considerable attention to the application of Photography to the various branches of science, now proposes to make arrangements for photographing Microscopical Preparations.

The objects will be enlarged by very perfect and powerful objectives, and photographed while thus enlarged.

Those possessing microscopes will at once notice the great advantage to be secured by such an arrangement. Few possess the skill to produce a drawing from a microscopic object, while the amount of detail involved in sketching anatomical preparations, can be mastered by few who are not professed artists.

When Mr. Lockwood's arrangements are complete a microscopist, for a moderate amount, will be enabled to have a perfect copy of any microscopic preparation, and as many duplicate as he requires to circulate among specialists, or his friends. Should he desire to publish the result of his researches, Mr. Lockwood can then photograph the object directly on the wood block, ready for the hand of the engraver.

The chief value of the use of Photography in such a case lies in the fact that such drawings, being prepared by the hand of nature, their integrity cannot be impeached, and that any charge of exaggeration or error cannot be maintained.

When Mr. Lockwood's arrangements are complete we will announce the fact in our microscopical column, but in the interval would be glad to hear from those who are likely to avail themselves of these facilities for promoting microscopical research.

NOTES.

Les Mondes proposes to apply the photophone to the study of the *aurora borealis*.

ON THE GALVANIC POLARIZATION PRODUCED BY METALLIC DEPOSITS.—The polarization of copper, employed as negative electrode in a solution of sulphate of zinc, is never null, as Lipmann believes, in cases where the solution contains traces of a salt of copper, and that the deposit of zinc is exceedingly slight and invisible. On the contrary, it has a value which may differ much, and which is so much the greater the smaller the quantity of a copper-salt contained in the solution, and the less the time which has passed from the moment when the polarizing current was interrupted.—D. MACALUSO.

ON THE ELECTROMOTIVE FORCE OF VOLTAIC ARC.—When an electric flux is established between two conductors of the same nature by means of a gaseous medium, which is commonly the vapor thrown off by their substance, the inequality of temperature of those portions of the conductors which are contiguous to such a medium appears to be a general fact. It seems not less probable that the extremity by which the positive electricity arrives, possesses the higher temperature. This is observed in a remarkable degree in the production of the voltaic arc between two carbons, by means of a current of constant direction. The idea of ascribing to this phenomenon a thermo-electric origin is not novel. According to the application of the principle of the equivalence of heat to electric phenomena, an electromotive force acting in the inverse direction of the current, corresponds to a disengagement of heat at the point of junction of two heterogeneous substances.—M. F. P. LE ROUX.

MAGNETIC ACTION UPON THE FLUORESCENT LIGHT PRODUCED BY THE NEGATIVE DISCHARGE IN AN EXHAUSTED SPACE.—If we take a well-exhausted cylindrical tube, with rectilinear electrodes placed in its axis, the fluorescent light formed by the cathodic rays consists, as is well known, of a green cylinder bounded by a circle. This circle undergoes transpositions if a magnet is allowed to act upon the discharge. It can be shown that these, whether simple or complicated cases, may be explained by the following hypothesis:—The cathodic rays, emanating from the negative electrode, pass on in a straight direction, and the current moves from the anode to the sides of the cathodic space, and from thence to the negative electrode. The magnet acts upon these currents according to Ampère's rule.—K. DOMALIP.